

5 INCREMENTAL AND CUMULATIVE IMPACTS FROM L-REACTOR OPERATION

5.1 INCREMENTAL IMPACTS FROM L-REACTOR SUPPORT FACILITIES

The resumption of L-Reactor operation would increase the number of operating reactors at the Savannah River Plant (SRP) from three to four. It would also increase effluents and emissions from fabrication (M-Area) and chemical processing (F- and H-Areas) support facilities at SRP by about 33 percent. Actual incremental increases might be less, depending on reactor operating schedules and the number of shifts required to support L-Reactor operation. Other SRP facilities that will be affected by L-Reactor operation include the waste management operations and an onsite steam-generating station in K-Area. This section describes the incremental environmental impacts from the SRP support facilities that would result from the resumption of L-Reactor operation under direct discharge of cooling effluent to Steel Creek (the reference case) and the preferred cooling-water alternative described in Section 4.4.2 and in detail in Appendix L.

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5.1.1 Nonradiological impacts

The nonradiological impacts from the SRP support facilities associated with the extra support effort due to L-Reactor operation will be fourfold: (1) an increase in the workforce, (2) an increase in water discharges to surface streams and seepage basins, (3) an increase in atmospheric pollutants, and (4) an increase in water usage. These nonradiological impacts are treated individually in Sections 5.1.1.1 through 5.1.1.4.

5.1.1.1 Socioeconomics

Approximately 160 employees are expected to be hired by 1984 for existing SRP facilities in support of the resumption of L-Reactor operation. About half have already been hired. Because the number of additional employees to be hired is less than 1 percent of the SRP labor force, and because the inmoving population associated with the potential 80 additional employees is less than 0.05 percent of the indigenous population in the six-county area, no impacts on local communities or services is expected.

5.1.1.2 Effluent discharge

Discharge to seepage basins

Separations Areas--SRP has discharged large volumes of liquids containing nonradioactive chemicals and low levels of radioactivity to the seepage basins in F- and H- (Separations) Areas (Figure 5-1) since 1954 and 1955, respectively. These discharges consist essentially of evaporator condensate from a number of different waste streams, all generated in operations involving radioactive materials. Some of the components in the wastewaters, including mercury,

chromium, and nitrate, have been retained in the seepage-basin soils; some have also entered the shallow ground-water system and are migrating through the saturated soil to outcrop zones, principally to wetland areas near Four Mile Creek (Du Pont, 1983c; Fenimore and Horton, 1972; Horton, 1974; Marter, 1977; Appendix F). In intensive ground-water monitoring studies of nitrate levels conducted in 1968 and 1969 at F- and H-Areas, nitrate concentrations ranged from 3 to 300 milligrams per liter (compared to background concentrations of 3 milligrams per liter in natural ground water).

The present discharges to the F- and H-Area seepage basins are not hazardous (under RCRA) except for frequent periods of low pH and infrequent discharges of hazardous levels of mercury and chromium. The mercury levels are associated with the processing of onsite reactor products and radioactive waste management activities; the chromium levels are associated with the processing of offsite fuels, radioactive waste management, and the removal of oxide from onsite target elements. The incremental increases to the F- and H-Area seepage basins from the operation of L-Reactor are not expected to be hazardous except for low pH and occasional discharges of mercury (H-Area only).

Most of the 435 and 1760 kilograms of mercury released to the F- and H-Area seepage basins, respectively, through 1982 has accumulated in the basin soils. Measurements in 1971 indicated that mercury discharged from seepage springs to Four Mile Creek at a rate of 0.36 gram per day; less than 0.1 percent of the mercury inventory is believed to have migrated to the creek. The ground-water downgradient from these seepage basins shows mercury concentrations 100 times higher than background levels. Recent quarterly monitoring indicates mean concentrations as listed in Table 5-1 (see tabulated monitoring results in Section F.5.3).

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From 1981 through early 1983, about 740 kilograms of chromium were discharged to the H-Area basin. Chromium concentrations in downgradient wells are 1.4 to 2.8 times background levels; in some cases, these exceed drinking-water standards. Large quantities of nitrate and sodium have also been released to these basins. Recent quarterly ground-water monitoring from wells around the F- and H-Area seepage basins indicates mean concentrations of chromium, nitrate, and sodium, as listed in Table 5-1.

The pH of the ground water near the F- and H-Area seepage basins ranges from about 3 to 6 for downgradient wells compared to a range of 5 to 7 for upgradient wells in the area. Appendix F contains additional ground-water monitoring results for the Separations Areas.

The chemical separations of product and waste from the irradiated L-Reactor fuel and target assemblies will result in additional effluent discharges to the seepage basins. During 1982, the average discharge rates were 0.24 and 0.30 cubic meters per minute to F- and H-Area basins, respectively. Because of changes in operating practices, principally by recycling as much as 80 percent of the acid and base drain header flow and rerouting laundry effluent, discharges to the basins in the Separations Areas have been reduced to 0.13 cubic meter per minute to the F-Area basins and 0.28 cubic meter per minute to the H-Area basins. Projected incremental discharges to these basins in support of L-Reactor operation will be approximately 0.04 and 0.09 cubic meter per minute, respectively. The continued use of these seepage basins is being evaluated on a

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Table 5-1. Mean concentrations in F- and H-Area seepage basin monitoring wells (milligrams per liter)

Constituent	Area	Upgradient wells	Downgradient wells ^a	Predicted increase for L-Reactor operation ^b
Mercury	F	0.0002	0.022	0.002
	H	0.0002	0.017	0.001
Chromium	F	0.030	0.041	0.00 ^c
	H	0.018	0.051	0.00 ^c
Nitrite (as nitrogen)	F	2.0	214.0	15.0
	H	1.4	46.0	3.2
Sodium	F	11.3	141.0	10.0
	H	3.6	60.0	4.2

^aAverage quarterly measurements (see Tables F-13 and F-14) in downgradient well showing greatest constituent concentration.

^bThe maximum increase in concentration predicted as the L-Reactor increment is 7 percent; it is stated here in terms of the concentration tabulated for the downgradient well.

^cThe incremental release of chromium from the operation of L-Reactor is calculated to be 0.2 kilogram per year to the H-Area basins only; it is not expected to cause a measurable increase of the concentrations in the conterminous plume.

site-wide basis (see Sections 6.1.6 and F.6). Contingent on Congressional authorization and approval of a FY 1986 funding request, DOE plans to operate an effluent-treatment facility by October 1988 to process the wastewater being discharged to these basins.

Based on past experience, about 8.5 kilograms per year of mercury, about 0.2 kilogram per year of chromium, and larger quantities of other chemicals, listed in Table 5-2, are expected to be discharged to seepage basins in the Separations Areas due to the operation of L-Reactor (ERDA, 1977; Horton and Carothers, 1975).

The reduction of flow rates to the seepage basins is expected to reduce the amount of nitric acid (nitrate ion) released to the basins. In addition, the amount of mercury released to the basins has decreased since the early and mid-1970s. Before 1972, approximately 7.9 and 9.4 kilograms of mercury were released per reactor to the F- and H-Area basins, respectively (Du Pont, 1983c). From the mid-1970s to 1982, the average contribution per reactor has been about 0.7 and 2.1 kilograms, respectively. Incremental releases of mercury from L-Reactor to these basins are expected to be 0.5 and 8.0 kilograms per year, respectively (Table 5-2). The addition of a second evaporator to process radioactive waste in the H-Area waste tanks has caused an increase in the amount of mercury added to the H-Area seepage basins.

Table 5-2. Estimated incremental nonradioactive releases to seepage basins, the separations areas, and the fuel/target fabrication area

Cation/anion	F-Area seepage basins (kg/year)	H-Area seepage basins (kg/year)	M-Area seepage basin (kg/year)
Ammonium	16	8	--
Calcium	110	620	--
Magnesium	50	220	--
Sodium	630	6,880	26,500
Iron	310	190	20
Copper	10	40	3
Aluminum	40	570	9,400
Lead	40	160	0.5
Zinc	100	400	--
Carbonate	0	3,270	--
Chlorine	30	570	260
Nitrite	5	90	50
Nitrate	15,450	34,390	86,400
Sulfate	510	1,530	275
Phosphate	30	4,280	21,700
Chromium	--	0.2	--
Mercury	0.5	8.0	--
Nickel	--	--	8,100
Fluorine	--	--	--
1,1,1 trichloroethane	--	--	6

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In 1975 approximately 2310 kilograms of chromium were discharged from the Receiving Basin for Offsite Fuels (RBOF) to the H-Area seepage basins (ERDA, 1977); an additional 120 kilograms were discharged to the F-Area basins. From 1981 through early 1983, the discharge rate to the F-Area seepage basins was essentially zero; it was about 295 kilograms per year to the H-Area basins. The operation of L-Reactor is expected to increase the amount of chromium released to the seepage basins in the Separations Area by only 0.2 kilogram per year. Since mid-1982, newly generated chromium waste from the RBOF facility has been processed through a waste evaporator, which greatly lowers the amount of chromium released to the H-Area seepage basins. Almost all the chromium released to these basins since 1982 has come from processing of radioactive waste produced before 1982. After being processed by the waste evaporator, the concentrated fractions are sent to the high-level radioactive waste storage tanks for processing by the Defense Waste Processing Facility.

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Public health and safety will be assured at F- and H-Areas and at the SRP Burial Ground. Section F.6 describes planned remedial actions. A potential intermediate-term problem exists from the use of these facilities, including the increment in support of L-Reactor operation. Contaminants discharged from the seepage basins and the seepage from the burial ground will flow to seepage springs, principally in wetland areas along Four Mile Creek. The radioactive constituents will meet DOE criteria for releases to uncontrolled areas when Four

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Mile Creek flows into the Savannah River. The direction of ground-water flow and the ground-water islands make it unlikely that any contaminated shallow ground water will reach offsite users. None of the incremental releases from the support of L-Reactor is expected to reach the Congaree Formation. Beneath the central portion of SRP, the flow directions in the Congaree and Tuscaloosa Formations are toward the Savannah River along paths that remain beneath SRP (see Figures F-25 and F-26). These formations discharge to the alluvium in the Savannah River valley. Onsite personnel will be protected by the extensive monitoring program. Monitoring of Congaree and Tuscaloosa wells in the central part of the SRP shows no evidence of contamination (Marine, 1965; Ashley and Zeigler, 1981). Based on water samples obtained (in 1965 and in February 1984) for tritium analysis from the Congaree Formation adjacent to the H-Area seepage basins [well 35-D (Figure F-34)], the green clay has protected the Congaree ground water effectively from contamination that enters the shallow ground-water system from the H-Area basins.

The discharges to the F- and H-Area seepage basins will not affect the heads in the Congaree and Tuscaloosa Formations, and pumping from the Tuscaloosa Aquifer will not affect the heads in the Congaree and overlying formations. The green clay at the base of the McBean Formation will prevent releases to these seepage basins from increasing the head in the Congaree. In addition, the clays in the upper Ellenton Formation and at the base of the Congaree Formation are effective sitewide confining units (see Table F-1); they limit the hydraulic connection between the Tuscaloosa and overlying Congaree Formations. For example, Tuscaloosa cones of depression at A-Area wells are not reflected in water levels in the overlying Tertiary sediments. At F- and H-Areas seepage basins, the changes in water-table elevations are expected to be local and small. Thus, the upward head differential between the Tuscaloosa and the Congaree will not be effected by discharges to the F- and H-Area seepage basins.

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As noted above, the green clay is also an important barrier to the downward migration of contaminants from the seepage basin to lower hydrostratigraphic units. In the Separations Areas, the green clay (about 2 meters thick) supports a head difference of about 24 meters between the McBean and Congaree Formations. Water samples obtained for tritium analysis from the Congaree near the H-Area seepage basin (well 35-D; see Figure F-34) in 1965 (Marine, 1965) and February 1984 indicate that the green clay has effectively protected the Congaree ground water from contamination seeping into the ground in the Separations Area. At the Par Pond pumphouse well (Figure F-13), the green clay also supports a large head difference and the water pumped from the Congaree Formation shows no evidence of tritium contamination, even though tritium concentrations in the pond were measured at 27,000 picocuries per liter. Water pumped from the Congaree by the pumphouse well exhibited tritium concentrations of 170 picocuries per liter or less, compared to concentrations of 260 ± 60 picocuries per liter in offsite well water (Ashley and Zeigler, 1981).

Calculations indicate that incremental nonradioactive releases to seepage basins in the Separations Areas in support of L-Reactor operation will increase the concentrations in the ground-water contaminant plume by about 7 percent. Table 5-1 lists the expected incremental changes calculated for the downgradient monitoring wells exhibiting maximum concentrations of mercury, chromium, nitrate (reported as nitrogen), and sodium. These incremental impacts to the ground water are small.

Contaminants that might enter the shallow ground water from the seepage basins in F- and H-Areas are expected to follow a ground-water path to Four Mile Creek and be discharged along seepage springs to the creek (Du Pont, 1983c; Root, 1983). As a result, concentrations of chloride, nitrate, sulfate, sodium, and calcium are higher in Four Mile Creek upstream from the C-Reactor cooling-water discharge than in Upper Three Runs Creek, but are similar to those in the Savannah River (DOE, 1982a). Tritium and nonvolatile beta activity are also elevated in this stretch of Four Mile Creek (Ashley and Zeigler, 1981); however, they do not exceed DOE concentration guidelines for uncontrolled areas. The expected incremental impacts to the water quality of Four Mile Creek above the C-Reactor outfall due to L-Reactor operation will be small (Table 5-3). The concentrations of pollutants entering Four Mile Creek, when mixed with creek water, are expected to be within drinking-water standards; the water quality of Four Mile Creek below the C-Reactor outfall will remain similar to that of the Savannah River. Tritium and other radionuclides in Four Mile Creek will not exceed DOE concentration guidelines for uncontrolled areas.

Incremental releases caused by L-Reactor operation from the Separations Area seepage basins to Four Mile Creek are expected to have only minor impacts on the ecosystem of the upper reaches of the creek. As listed in Table 5-3, nutrient levels are expected to increase and to result in an increase in the populations of primary producers forming the base of the food web. This will exert some stress on the depauperate fauna found in the creek above the C-Reactor outfall. The depauperate condition of the fauna in this area of the creek might be related to thermal isolation caused by C-Reactor and shading of the overstory (Du Pont, 1981a; McFarlane, 1976).

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The water quality of the Savannah River is expected to meet the criteria for a Class B waterway below Four Mile Creek when the pollutants that enter the river from the F- and H-Area seepage basins are mixed with river water (see Ashley and Zeigler, 1981). The water quality below the SRP is not expected to be adversely affected by SRP effluent discharges (see Table 4-6 and Marter, 1970). Radiological dose commitments from releases seeping from F- and H-Area basins are discussed in Section 5.1.2 and Appendix B. DOE will be conducting studies for the eventual phasing-out of these seepage basins (Section F.6).

In summary, the projected L-Reactor incremental releases to the Separations Areas seepage basins will be 0.04 cubic meter per minute to the F-Area basins and 0.09 cubic meter per minute to the H-Area basins. The chemicals in these releases are expected to increase the concentrations of constituents in the contaminant plume by about 7 percent. The water quality of Four Mile Creek will be degraded as the ground water flows into the creek through seepage springs in low-lying wetland areas. Concentrations of constituents in the creek water will be increased by about 7 percent from F- and H-Area seepage-basin releases to the creek. The average quality of the creek water is expected to be similar to that of the Savannah River above the outfall for C-Reactor, except for pH and nitrate and nitrite solutions.

Fuel and Target Fabrication Area--Waste effluents from production operations in the Fuel and Target Fabrication (M-) Area, shown in Figure 5-1, have been discharged to process sewers since startup in 1952. A seepage basin was put in service in 1958 to settle out and contain uranium discharges from fuel-element production operations. At present very little wastewater seeps from the basin. Instead, most of the water overflows the basin and enters the ground at

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Lost Lake (see Figure F-35). The waste effluents have included large volumes of volatile organic compounds used as metal degreasing agents. Some of these solvents have evaporated; however, substantial quantities have seeped into the ground from effluent sewer leaks, the seepage basin, overflow to Lost Lake, and other miscellaneous spill sites. This seepage has entered the shallow ground-water system within the Tertiary Coastal Plain sediments. Ground-water samples taken near the seepage basin have exhibited concentrations of organic degreasers no longer used at SRP as high as 220 milligrams per liter in the water-table aquifer. In the Tuscaloosa Formation, concentrations as high as 27 micrograms per liter have been measured in ground-water samples. However, this contamination appears, on the basis of well surveys and contaminant monitoring results (Section F.5.4), to have resulted from the migration of organic degreasers in the Tertiary sediments down the annuli of wells with defective cement grout between the sediment and the well casings (Geraghty and Miller, 1983; Steele, 1983). Approximately 160,000 kilograms of organic degreasers are believed to have entered the ground in M-Area (more details are provided in Appendix F; Du Pont 1982c, 1983c; Geraghty and Miller, 1983; Steele, 1983). However, the discharge of volatile organic compounds in process wastewaters from M-Area operations has been reduced appreciably by recent changes in operating practices.

Effluent discharged to the M-Area seepage basin frequently meets the definition of hazardous waste because of pH. Typically, the waste stream contains 1,1,1-trichloroethane, but not at levels considered to be hazardous (J. D. Spencer letter to G. A. Smithwick dated May 13, 1983). The pH in the upgradient wells (see Table F-15) ranged from 4.5 to 10.6 during recent quarterly monitoring. At the M-Area seepage basin, there are three distinct pH plumes (Du Pont, 1982c). The pH lobe that appears to originate at the basin and move in the direction of the water-table ground-water flow has a pH range from 9.8 to 11.8. In the ground water beneath the process sewer and the seep area at Lost Lake and between the basin and Lost Lake, the pH ranges between 5.0 and 6.0.

Recent quarterly ground-water monitoring from wells encompassing the M-Area seepage basin and Lost Lake indicate the mean chromium, nitrate, and sodium concentrations listed in Table 5-4.

Currently (February 1984), about 0.48 cubic meter per minute of process and nonprocess effluent is being discharged to the M-Area seepage basin, which overflows to Lost Lake, a nearby Carolina bay. The incremental release associated with L-Reactor is estimated to be 33 percent of the flow rate to the basin (about 0.16 cubic meter per minute at present). Changes in operational practices have reduced the amount of rinse water used in the fabrication of fuel and targets, principally by repiping and rearranging existing rinse tanks and using counter-current and stagnant rinse techniques rather than once-through rinses; these practices are expected to reduce the amount of wastewater discharged to the basin to about 0.05 cubic meter per minute by the end of 1984. The incremental discharge from M-Area that would support the operation of L-Reactor includes approximately 6 kilograms per year of a chlorinated degreasing solvent (1,1,1-trichloroethane) and quantities of other chemicals listed in Table 5-2.

In A- and M-Areas, public health and safety will be protected by the extensive SRP monitoring program and by plume management and remedial action strategies. The sewer line to Tims Branch from M-Area no longer receives process wastewater and the line to the M-Area basin is being repaired. When monitoring first confirmed the presence of chlorinated hydrocarbons in water from A-Area

Table 5-4. Mean concentrations in M-Area seepage basin and Lost Lake monitoring wells (milligrams per liter)

Constituent	Upgradient wells	Downgradient wells ^a	Maximum increase predicted for L-Reactor operation ^b
Chromium	0.016	0.58	0.04
Nitrite (as nitrogen)	2.5	54.7	3.8
Sodium	11.4	86.9	6.1

^aAverage quarterly measurements (see Tables F-13 and F-14) in downgradient well showing greatest constituent concentration.

^bThe maximum increase in concentration predicted as the L-Reactor increment is 8 percent; it is stated here in terms of the concentration tabulated for the downgradient well.

Tuscaloosa wells (Appendix F), the contaminated wells were shut down to protect onsite personnel. Monitoring in A-Area, M-Area, and neighboring municipal water wells has shown that the contaminants have not migrated offsite and that no off-site health risk will exist in the foreseeable future. Contaminants that might reach the Tuscaloosa Formation will be discharged to the alluvium in the Savannah River valley (Section F.2.3.2; Du Pont, 1983c). After they become diluted along the travel path (Figure F-26), these contaminants could be intercepted by some SRP production wells. State and Federal agencies are reviewing plans for impeding the growth of the contaminant plume and the removal of the chlorinated hydrocarbons using recovery wells, and a large air stripper. In addition, the health of onsite personnel will be protected by changes in the water distribution system, which will obtain potable water only from the A-Area Tuscaloosa wells that are unlikely to receive contamination from Tertiary aquifers.

The high concentrations of chlorinated hydrocarbons found in the A- and M-Area shallow (Tertiary) ground-water system are being removed by both a pilot and a prototype air-stripper unit with capacities of 0.075 and 0.18 cubic meter per day, respectively. These demonstration projects will be phased out as the A- and M-Area ground-water remedial action project (Steele, 1983) is being implemented in August 1984. This project will consist of nine 200-foot-deep interceptor/recovery (I/R) wells and an air stripper with a capacity of 1.5 cubic meters per minute, about three times that of the current discharges to the M-Area seepage basin. It has been designed to prevent chlorinated hydrocarbon contaminants in the shallow ground-water system (within the Tertiary Coastal Plain sediments) from reaching the drinking water of any offsite well or the Tuscaloosa Aquifer. Based on small-scale and prototype systems, the production (I/R) well and air-stripper system is expected to remove about 30 tons of chlorinated hydrocarbons per year for the first few years of operation. Thereafter, the removal rate will decrease as contaminant concentrations decrease. Liquid effluent from the air-stripper column (about 1.1 cubic meters per minute) will

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be routed to the A-Area powerhouse process-water system or used as nonprocess cooling water in M-Area. In either case, the wastewater would be discharged through an NPDES-permitted outfall.

Use of the M-Area seepage basin is scheduled to be discontinued by April 1985. At that time, M-Area liquid effluent that would normally be sent to the basin will be processed by a wastewater-treatment plant designed to remove about 650 metric tons per year, including the L-Reactor increment and a 20-percent contingency factor. The plant will be composed of (1) a uranium recovery facility, (2) a facility to remove suspended solids, aluminum, nitrates, phosphates, heavy metals, and oil and grease, and (3) a waste solidification facility to concentrate solutions by evaporation and to mix the concentrate with cement and flyash to form a solid-waste form for storage or disposal.

Process wastewater released to the seepage basin after the restart of L-Reactor (before the operation of the M-Area wastewater-treatment plant) will reach the water table in about 10 to 17 years. These waters will be intercepted by the I/R well system. The cone of depression resulting from pumping by the I/R system will be extensive. For example, the area within the 3-meter drawdown isopleth is expected to have an area of several hundred acres and to extend about 180 meters beyond Lost Lake after 10 years of pumping; below the seepage basin, the expected drawdown is 6 meters. Thus, the remedial-action project will readily intercept, recover, and process L-Reactor (and other) releases to the M-Area seepage basin-Lost Lake system that are discharged before the operation of the wastewater-treatment facility in April 1985.

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Incremental pumping from the Tuscaloosa Aquifer in support of L-Reactor will cause an increase in the downward head differential between the Congaree and Tuscaloosa Formations of about 0.75 meter at the M-Area seepage basin. This will tend to increase both the downward migration of contaminants in the ground water and the tendency for migration through the thick, low-permeability lower Congaree and upper Ellenton clay units. After 1 year of pumping by the I/R well system, the expected cone of depression in the Tertiary ground-water system will be nearly coincident with the 100-microgram-per-liter concentration isopleth of the contaminant plume. Appreciable concentrations of contaminants are unlikely to migrate through the clays of the Congaree and Ellenton Formations overlying the Tuscaloosa before the I/R cone of depression reduces the effects of incremental pumping. The I/R cone of depression will grow quickly; it is expected to counter any effect of incremental pumping for L-Reactor. This system is projected to reduce the downward head differential beneath the Lost Lake seepage area by 1.2 meters and 3.6 meters after 1 and 10 years of I/R well operation, respectively.

Nitrate and other contaminants associated with the M-Area process wastewater that reach the water table will be removed by the I/R system and pumped to the air-stripper system during its period of operation (40 years). Chlorinated hydrocarbon concentrations in the feed system to the air stripper are expected to range initially from 38,000 to 115,000 micrograms per liter; nitrate concentrations are estimated to range from a few to about 35 milligrams per liter.

L-Reactor is expected to have a very small impact on the operation of this ground-water remedial project. The incremental seepage from L-Reactor support operations will be not more than 8 percent of the design capacity of the I/R

wells, because the increment of 0.16 cubic meter per minute is expected to decrease to about 0.02 cubic meter per minute by the end of 1984. The small incremental discharges will have only a minor and local effect on water-table contaminant concentrations and elevations beneath the M-Area seepage basin and Lost Lake; the effects will be dissipated during the protracted period of seepage to the water table. The thick, low-permeability clay units of the lower Congaree and upper Ellenton Formations will remain effective confining units for the Tuscaloosa Aquifer; this is shown by the fact that the cone of depression from A-Area withdrawal from the Tuscaloosa Aquifer is not reflected in the water levels in the overlying sediments.

Without the I/R well system, the incremental discharges to the M-Area seepage basin would have only a small impact on concentrations of contaminants in the plume. Calculations indicate that these releases will increase concentrations by about 8 percent. Table 5-2 lists the expected incremental changes calculated for the downgradient monitoring wells that exhibit maximum concentrations of chromium, nitrate (expressed as nitrogen), and sodium.

Small quantities of uranium in the M-Area process wastewater will become associated with the clay materials in the subsurface, such as the green clay (if present), because of uranium's relatively high distribution coefficient (K_d). Ultimately, this material will probably reside in the basal Congaree and upper Ellenton clay units, which are effective confining units throughout the SRP.

In summary, the current project L-Reactor incremental liquid releases to the Fuel and Target Fabrication Area seepage basin are 0.16 cubic meter per minute; by the end of 1984, they will be 0.02 cubic meter per minute. The small incremental discharges will have only a minor and local effect on contaminant levels in the Tertiary ground-water system beneath the seepage areas; the effects will be dissipated during the protracted period of seepage to the water table. The thick, low-permeability clay units of the lower Congaree and upper Ellenton Formations will remain effective confining units for the Tuscaloosa, and incremental releases to the M-Area basin will not contaminate the ground water within this formation.

The A- and M-Area ground-water remedial action project is scheduled to be operating by August 1984. The I/R wells, which will have a capacity of at least 9 times the incremental release, are expected to intercept seepage from the basin and Lost Lake areas when it reaches the water table in about 10 to 17 years. Until the I/R system has been fully operational for about 1 year, the tendency for contaminants in the Tertiary contaminant plume to move downward will be increased as the result of incremental pumping for L-Reactor. Thereafter, the I/R system should counter the effects of incremental pumping. Appreciable concentrations of contaminants are unlikely to migrate through the clays confining the Tuscaloosa from L-Reactor restart until the I/R system has been pumping for 1 year. Use of the M-Area seepage basin is scheduled to be discontinued by April 1985, when a wastewater-treatment facility will be in service.

Ash basin

Additional discharges of coal ash will be sluiced (mixed with water and discharged) to the K-Area ash basin for disposal as a result of the production of steam for L-Reactor operation. The additional burning of coal with an ash

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content of about 13 percent will produce approximately 815 metric tons of ash per year. Incrementally, this ash will increase the K-Area steam-plant discharge to the ash basin by about 15 percent. A proposed project would adjust the pH of the sluicing water so the water is within discharge limits (SCDHEC, 1979). Leachate from the ash basin will enter the shallow ground-water system of the Barnwell Formation, from which it will migrate to Pen Branch. Little impact is anticipated.

Effluent treatment processes

Alternatives to the discharge of process wastewaters to the seepage basins in the fuel and target fabrication and chemical separations areas are being investigated, with the intent that these basins will be closed and that decommissioning activities will begin in 1985 and 1988, respectively.

DA-7 | In the fuel and target fabrication area, an integrated system is being designed for the treatment of all M-Area process effluents except clean (non-contact) cooling water. This facility, which is scheduled for operation by April 1985, will utilize precipitation, evaporation, cation exchange, electro-dialysis, and water purification (rinsing) techniques to remove chemicals from the wastewater and allow discharge to Tims Branch through an NPDES-permitted outfall.

DA-7 | For the Separations Areas seepage basins, a waste-treatment facility is being developed to remove radioactive isotopes, hazardous heavy metals, and other dissolved and undissolved solids; direct discharge to Four Mile Creek will be used, through an NPDES-permitted outfall. Unit operations of filtration, reverse osmosis, and ion exchange will be utilized to clean up the process effluent. Operation of this facility is scheduled for October 1988. DOE will submit a FY 1986 funding request to Congress for approval.

Releases to surface streams

The operation of L-Reactor will cause an incremental increase of about one-third in the direct discharge of liquid effluent from the separations areas to surface streams. As listed in Table 5-5, F-Area will discharge an additional 890 liters per minute to Four Mile Creek; the increment to Four Mile Creek from H-Area will be about 1040 liters per minute (Du Pont, 1982b). Table 5-5 also lists the expected concentrations of pollutants in the liquid effluents to these streams and compares the concentrations to applicable drinking-water standards or water-quality criteria.

In general, at the outfall these releases already meet the State of South Carolina release requirements for Class B streams (SCDHEC, 1981). However, the pH of these discharges will occasionally exceed standards and require treatment.

5.1.1.3 Atmospheric releases

Incremental impacts of nonradiological atmospheric pollutants will occur because of the increased steam, electricity, and other processes that L-Reactor operations will require. However, these are not expected to cause any violations of regulations or air-quality standards.

L-Reactor production will increase the amount of fuel and target material processing in F-, H-, and M-Areas. The main environmental impact of increased operations in these facilities will be the added release of NO_x to the atmosphere.

Projected 1985 NO_x releases from F-Area will rise at least two-fold due to both L-Reactor restart and other SRP program changes. NO_x emissions from H-Area will decrease by a factor of two. About 25 percent of the total F-, H-, and M-Area emissions in 1985 will result from processing L-Reactor materials (Table 5-6). Air emissions permits for these facilities have been revised to reflect process changes.

Table 5-6. Summary of air pollutant releases from L-Reactor support facilities

Area	Projected 1984-1985 emission tons/yr		
	SO _x	TSP	NO _x
K-Area coal	130	28	45
L-Area diesels	4	4	59
F	<1	<1	197
H	<1	<1	28
M	<1	<1	26
Total SRP ^a	10,000	2500	5500

^aBased on adjusted values in ERDA (1977).

NO_x releases resulting from L-Reactor operations are higher than other air pollutant emissions increases (Table 5-6). Overall, L-Reactor restart will increase future SRP NO_x emissions by about 5 percent. Sulfur dioxide and total suspended particulate releases will add about 1 percent. Releases related to L-Reactor operation will contribute 1.1 micrograms per cubic meter NO_x to the ambient air at the SRP boundary. This compares to 15 to 23 micrograms per cubic meter NO_x estimated from all other SRP sources in 1985. Total sulfur dioxide and total suspended particulate releases from L-Reactor restart will add less than 1 gram per cubic meter each.

5.1.1.4 Water usage

Surface water

Only minor amounts of surface water will be used by SRP facilities to support L-Reactor operation, because ground water will be the principal source of process water at these facilities. It is estimated that the K-Reactor steam plant will require about 0.005 cubic meter per second additional water from the

Savannah River to produce steam for L-Reactor (Du Pont, 1981b). Sections 4.1 and 4.4.2 describe surface-water use for L-Reactor; Section 5.2 describes cumulative surface-water use.

Ground water

Incremental ground-water pumping from the Tuscaloosa Formation, required to support the resumption of L-Reactor operation, will occur in five areas on the SRP: K-Area (steam plant), the central shops, and F-, H-, and M-Areas (Table 5-7). The incremental drawdowns listed in Table 5-6 represent the best estimates based on the recommended drawdown curve (Siple, 1967; Section F.4.2). At F-Area, the incremental pumping will be about 1.13 cubic meters per minute. After the F-Area powerhouse is placed in standby status in September 1984, the total ground-water withdrawal from the Tuscaloosa in F-Area will be about 4.54 cubic meters per minute, including the increment for L-Reactor. No incremental pumping in support of L-Reactor is expected at H-, A-, and M-Areas, where water conservation and other operational procedures have been instituted. However, if L-Reactor does not restart, ground-water withdrawal at these facilities might decrease by as much as 25 percent. Ground-water withdrawal by A-Area wells could be reduced by 1.1 cubic meters per minute when the wastewater from the M-Area air stripper is used in the A-Area powerhouse to augment the process water flow (Steele, 1983); this potential reduction is not considered in this EIS.

The incremental withdrawal of water from the Tuscaloosa Formation at K-Area will not affect the protection of the Ellenton and Tuscaloosa aquifers afforded by the upward head differential between the Tuscaloosa and Congaree Formations. In the Central Shops and F-Area, this head differential no longer exists at the producing wells, and the downward head differential at these wells will be increased when the incremental pumping for L-Reactor starts. Increased pumping at H-Area has also caused a downward head differential at H-Area wells. However, the hydrostratigraphic properties of the overlying units will continue to offer protection to the Ellenton and Tuscaloosa aquifers at the pumping wells. At the seepage basins the upward head differential between the Tuscaloosa and Congaree Formations will be gradually reduced by drawdown to about 3.7 meters in F-Area. In H-Area the head differential will become about 0.6 meter downward. The head differential in the Central Shops Area will also become downward (Table 5-7).

In A- and M-Areas the hydrostratigraphic characteristics of the subsurface materials are different from those in F- and H-Areas (Table F-1). In addition, the downward head differential between the Congaree and Tuscaloosa Formations will be increased by about 0.75 meter at the M-Area seepage basin as the result of increased pumping to support L-Reactor. This could increase the tendency for contaminants already present in the ground water to move downward. As noted in Appendix F, the ground-water aquifers beneath M-Area have received contaminants contained in M-Area effluents. Current plans call for (1) establishing a series of additional interceptor/recovery wells by August 1984 (Steele, 1983) to remove these contaminants before they migrate offsite or into the Tuscaloosa Aquifer, and (2) discontinuing the use of the M-Area settling basin by April 1985. An extensive monitoring and cleanup program has been initiated. Contaminants that might reach the Tuscaloosa Formation eventually would be discharged to alluvium in the Savannah River valley. After dilution and radioactive decay had occurred along the travel path, these contaminants could be intercepted by some SRP production wells.

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Ground-water flow in the Tertiary ground-water system below M-Area is also away from the nearest site boundary and toward the Savannah River (Section F.2.3.2 and Figure F-26; Du Pont, 1982). More recent water-level measurements indicate that the flow direction in the M-Area Tertiary ground-water system is to the south in the lower part of the system; the dominant flow direction in the overlying water-table aquifer is to the west-southwest.

The 1985 projected ground-water consumption from the Tuscaloosa at SRP, including that in support of L-Reactor [0.94 at L-Area + 4.94 total incremental (Table 5-7) = 5.9 cubic meters per minute], is estimated to be 25.4 cubic meters per minute. This represents a 7-percent increase over the 1982 SRP withdrawal from the Tuscaloosa of 23.8 cubic meters per minute, but a 6-percent decrease from the 1983 withdrawal rate of 27.0 cubic meters per minute (Tables 5-7 and F-10).

Computer modeling by Marine and Routt (1975) indicated that the ground-water flux in the aquifer is about 110 cubic meters per minute throughout a study area that includes SRP and nearby users (Figures F-25 and F-31). The current ground-water flux through this study area is estimated conservatively to be 51 cubic meters per minute, which is the lower bound estimate. This flux estimate compares with the projected withdrawal rate of about 36.9 cubic meters per minute (11.5 for neighboring offsite users + 25.4 projected SRP usage, including L-Area and support facility incremental use; see Section 5.2.3 for a discussion of cumulative ground-water withdrawal). The SRP projected pumpage rate of 25.4 cubic meters per minute compares with 37.8 cubic meters per minute, which Siple (1967) concluded could be pumped at the SRP with no adverse effects on the pumping capabilities of existing 1960 wells, particularly additional wells if spaced to minimize interference between wells. In 1960, SRP pumpage from the Tuscaloosa was about 18.9 cubic meters per minute (Siple, 1967).

Calculations were performed to evaluate the relationship between ground-water withdrawal and water levels in the Tuscaloosa Aquifer (see Section F.4.2). They showed that water levels in municipal wells near SRP would decrease slightly (0.0 to 0.4 meter) from the 1982 level when pumping at SRP increases (after September 1984) to 25.4 cubic meters per minute (which includes pumping at L-Area and incremental pumping in support of L-Reactor operations). Table 5-8 lists the declines calculated for wells near SRP. These drawdowns reflect rapid (about 100 days; Mayer et al., 1973) adjustments in equilibrium levels rather than aquifer depletion. These declines, calculated for municipalities and other users that would probably experience the greatest impacts from pumping at SRP, are less than half the increase in water levels experienced in Tuscaloosa wells in 1973 in response to an appreciable increase in water precipitation (see Figure 3-11). Long-term cyclic changes of 2 meters have been observed in water levels of the Tuscaloosa Aquifer in wells near SRP (see Figure F-12). In addition, drawdown calculations showed that the declines in water levels at monitoring wells P7A, P54, and P3A since 1974 were related primarily to increased ground-water withdrawal at SRP. Because pumpage will be relatively stable over the next 6 years (see Section 5.2.3), the 0.16-meter-per-year decrease reflected in monitoring well P7A (Figure 3-11) is expected to be arrested (equilibrium water levels are not expected to change appreciably).

The withdrawal of ground water from the Tuscaloosa Aquifer in support of L-Reactor operation is not expected to affect the quality of water.

Table 5-8. Decline in Tuscaloosa Aquifer water levels due to pumping at all SRP facilities^{a,b,c}

Offsite Location	Equilibrium declines in water levels from 1982 levels (meters)	
	Incremental pumping (25.4 m ³ /min)	Cumulative pumping (26.5 m ³ /min)
Beach Island	<<0.1	<<0.1
New Ellenton	<0.1	<0.1
Talatha	0.1	0.1
Jackson	0.4	0.4
SRP boundary opposite A-Area	0.4	0.4
Willinston	<<0.1	<<0.1
Barnwell NFP	<0.1	<0.1

^aComparison made to conditions in May and June 1982 using average withdrawal rates at SRP for 1982 (23.8 cubic meters per minute).

^bCalculations were made using the leaky aquifer model (Siple, 1967) discussed in Section F.4.2.

^cThese drawdowns from incremental and cumulative pumping will occur rapidly; near-equilibrium levels are expected in about 100 days. They have about the same magnitude as changes in water levels in response to short-term changes in winter precipitation (Figure 3-11). Long-term cyclic changes in Tuscaloosa Aquifer water levels of 2 meters have been observed in wells in the SRP area (Figure F-12).

In conclusion, the incremental ground-water withdrawal from the Tuscaloosa Aquifer in support of L-Reactor operation (about 4.94 cubic meters per minute) is expected to have little (less than 0.4 meter) impact on offsite water levels. Beneath the Central Shops and H-Area basins, the head differential between the Tuscaloosa and Congaree is expected to become downward; the differential in A- and M-Areas is expected to become increasingly downward. However, the green clay has a very low permeability and appears to be an effective barrier to the downward migration of pollutants wherever it is present on SRP. The lower Congaree and upper Ellenton clay units act as similar barriers for the Tuscaloosa Aquifer.

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5.1.2 Radiological effects of support facilities

The resumption of L-Reactor operation will result in an increase of about 33 percent in radioactive discharges from the support facilities (i.e., central shops area, heavy-water area, fuel fabrication area, and the separations areas). Releases from support facilities associated with L-Reactor operation will build up gradually; during the first year of L-Reactor operation they will be less than 50 percent of the equilibrium values in succeeding years. However, for the purpose of the present analysis, it is assumed that first-year releases are equal to the expected equilibrium annual average releases. This section characterizes the radioactive releases from support facilities and presents the radiological impact of the releases on the maximally exposed individual and on population groups. Appendix B contains the methodology of the calculations and detailed dose results, including tables that provide the doses by age groups, organs, and pathways.

5.1.2.1 Liquid releases

Liquid radioactive releases will increase from the chemical separations areas, the fuel fabrication area, the heavy-water rework area, and the central shops area as a result of the resumption of L-Reactor operation. Tables 5-9, 5-10, and 5-11 list the expected annual average incremental increases in liquid releases from support facilities to surface streams, to seepage basins, and to surface water from the seepage basins, respectively. The values listed for the releases from these areas to surface streams and seepage basins are based on the average releases from the areas for 1978, 1979, and 1980, which were associated with the operation of three reactors. Since the mid-1950s, SRP has discharged large volumes of liquids containing low levels of radioactivity to the F-, H-, and M-Area seepage basins. The seepage basin soils have retained some of the components in the process wastewaters; others have entered the shallow groundwater system and are migrating to outcrop zones along Four Mile Creek (Fenimore and Horton, 1972; Marter, 1977). The migration of L-Reactor-related radioactivity from seepage basins to surface streams will occur approximately 4 years after initial discharge to the basins.

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5.1.2.2 Atmospheric releases

The restart and operation of L-Reactor will increase the release of radionuclides to the atmosphere from the chemical separation areas, the fuel fabrication area, and the heavy-water rework area. Table 5-12 lists the annual average incremental increase in releases of radioactivity to the atmosphere from L-Reactor support facilities. These incremental releases are based on the annual average release for these facilities for three reactor operations for 1978, 1979, and 1980.

Table 5-11. Estimated incremental releases of radionuclides to streams from seepage basins due to operation of support facilities (curies per year)

Radionuclide	Central shops area ^a	Fuel fabrication area ^b (M)	Separations areas ^c (F&H)	Total
H-3	1.7×10^{-1}	--- ^d	3.2×10^3	3.2×10^3
Co-60	1.9×10^{-6}	---	3.3×10^{-2}	3.3×10^{-2}
Zn-65	---	---	5.8×10^{-4}	5.8×10^{-4}
Ru-106	---	---	6.9×10^{-1}	6.9×10^{-1}
Sb-125	---	---	4.2×10^{-3}	4.2×10^{-3}
Ce-144	---	---	1.0×10^{-1}	1.0×10^{-1}
Pm-147	---	---	4.4×10^{-2}	4.4×10^{-2}

^aConservatively estimated travel time to outcrop equals 3.3 years.

^bOnly uranium isotopes will be released to this basin (see Table 5-10).

Due to their adsorption on soils, they will not be discharged from the ground water during L-Reactor operation.

^cTravel times to outcrop from F- and H-Areas are 6.7 and 1.1 to 3.8 years, respectively. For calculational purposes, the travel time was assumed to be 3.8 years from both areas.

^dNot detectable.

TC|

5.1.2.3 Dose commitments from L-Reactor support facilities operations

Maximum individual dose from liquid releases

The total-body dose to the maximally exposed individual from liquid effluents from the operation of the L-Reactor support facilities was calculated to be 0.022 millirem to an adult in the first year of operation and 0.050 millirem in the tenth year (after seepage-basin contributions start). The maximum organ dose was calculated to be 0.18 millirem to a child's bone in both the first and tenth years.

Population dose from liquid releases

The total-body dose due to liquid releases from L-Reactor support facilities to the population within 80 kilometers of the Savannah River Plant was calculated to be 0.044 person-rem in the first year and 0.048 person-rem in the tenth year. The bone dose was 0.25 person-rem in both the first and tenth

years. The corresponding incremental total-body dose to the populations consuming river water at the Port Wentworth and Beaufort-Jasper water treatment plants was calculated to be 0.95 person-rem in the first year and 5.3 person-rem in the tenth year. The bone dose was 7.9 person-rem in both the first and tenth years.

Maximum individual dose from atmospheric releases

The individual who would receive the highest dose from atmospheric releases from L-Reactor support facilities was assumed to reside continuously on the SRP boundary. The location on the site boundary where this individual resides was selected as the one where the total maximum offsite doses from L-Reactor and support operations are predicted to occur. The total-body dose to the maximum individual from support facility operations was calculated to be 0.074 millirem to a child in the first year and 0.022 millirem in the tenth year. More than 75 percent of the total-body dose is from tritium; the major dose pathways are the ingestion of vegetables and milk. The maximum organ dose was calculated to be 0.56 millirem to an adult's thyroid in the first year and 0.62 millirem in the tenth year. Iodine-129 contributes more than 90 percent of these doses; the ingestion of vegetables and milk are the major dose pathways.

Population dose from atmospheric releases

The incremental total-body dose to the population within 80 kilometers of the Savannah River Plant due to L-Reactor support facilities was calculated to be 2.8 person-rem in both the first and tenth years. More than 70 percent of the total-body dose is from tritium. Inhalation and the ingestion of vegetables are the major dose pathways. The highest organ doses were 96 person-rem to the thyroid and 27 person-rem to the skin. More than 95 percent of the thyroid dose is from iodine-129 with the ingestion of vegetables being the dominant dose pathway; more than 90 percent of the skin dose is from krypton-85 via exposure to the plume of released radioactivity.

5.1.2.4 Summary - offsite dose commitments from support facility operation

Table 5-13 summarizes the maximum individual dose and population dose from L-Reactor support facilities. The numbers listed as totals for individual and population doses are conservative maximums; to receive these doses, the "composite" individual (or population) would have to occupy several locations simultaneously.

TC | The composite maximum individual dose of 0.087 millirem in the first year and 0.072 millirem in the tenth year is less than 0.1 percent of the average dose of 93 millirem (Du Pont, 1982a) received by an individual living near the SRP site from natural sources. The doses this individual receives are well below DOE protection guides of 500 millirem to the total body and 1500 millirem to other organs (DOE, 1981). The maximum population dose of 8.1 person-rem (tenth year) is about 0.007 percent of the dose of about 109,000 person-rem to the population living within 80 kilometers of the Savannah River Plant and the Beaufort-Jasper and Port Wentworth drinking water population from natural radiation sources.

Table 5-13. Summary of total-body dose commitments
from L-Reactor support facility operation

Source of exposure	1st year		10th year	
	Adult	Child	Adult	Child
MAXIMUM INDIVIDUAL DOSE (millirem per year)				
Atmospheric releases ^a	0.050	0.074	0.015	0.022
Liquid releases	<u>0.022</u>	<u>0.013</u>	<u>0.050</u>	<u>0.050</u>
Total	0.072	0.087	0.065	0.072

Source of exposure	Dose within 80 kilo- meters of SRP		Port Wentworth and Beaufort-Jasper doses	
	1st year	10th year	1st year	10th year
Atmospheric releases	2.8	2.8	--	--
Liquid releases	<u>0.044</u>	<u>0.048</u>	<u>0.95</u>	<u>5.3</u>
Total	2.8	2.8	0.95	5.3

^aThe location of the maximum individual is where the receptor receives the largest total dose from the L-Reactor plus its support facilities; because of the increase in tritium releases from L-Reactor until equilibrium is reached, this location is different in the first and tenth years.

5.1.2.5 Health effects of support facilities operations

Risk estimators used to project health effects were 120 cancers and 257 genetic effects per 1,000,000 person-rem exposure to the population. Using these estimators and the values for regional doses (Table 5-13), the radiation-induced health effects that might occur eventually as a result of operation of support facilities for L-Reactor (from atmospheric and liquid releases) include a maximum of 0.0004 excess cancer fatality and 0.0007 additional genetic disorder in the population within 80 kilometers of the Savannah River Plant from releases occurring in the first or tenth year of operation. Health effects that might eventually occur in the downstream Savannah River water-consuming populations of Port Wentworth and Beaufort-Jasper include a maximum of 0.0003 and 0.0007 fatal cancer as a result of releases in the first and tenth years, respectively. The maximum incidence of genetic disorders to these populations would be 0.0002 and 0.001 as a result of first- and tenth-year releases, respectively.

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